

Working with Ethylene Oxide



Meeting WISHA Training Requirements

- To meet the WISHA training requirements for ethylene oxide, you must include information specific to your worksite as indicated in slides #15, 21, 29, 33, 39, 51, 54, and 64.
- Preview this program and include your specific workplace information before conducting the training. Modify, add, delete, or otherwise customize slides as needed for your workplace.
- It is recommended that you keep an attendance roster for your records to document training.

How To Use This PowerPoint Program

- Users with PowerPoint can download, edit, and use the program for training with a laptop and multimedia projector.
- Additional information is also found in the Notes section of this presentation below the slides. You can read the text in quotations found in the Notes section or use your own words.
- If you want to print out this program, the PDF file uses less computer memory and prints faster.



Ethylene Oxide

What this training will cover:

Characteristics of Ethylene Oxide

Health hazards of ethylene oxide

How you can be exposed to ethylene oxide

Control of your ethylene oxide exposure

How to protect yourself from ethylene oxide

Use of respirators

Medical surveillance & medical removal

WISHA rules on ethylene oxide

What is Ethylene Oxide (EtO)?

- Colorless gas above 51°F, liquid below 51°F
- Ether-like, sweet odor at toxic levels
- Flammable, explosive
- Highly reactive, penetrating
- Heavier than air
- EtO liquid ➡ secondary contamination

Ethylene Oxide (EtO)

Synonyms:

- 1,2-epoxyethane
- oxirane
- dimethylene oxide
- ethene oxide

Uses of Ethylene Oxide

- Intermediate in chemical manufacturing
 - * ethylene glycol
 - polyester polymers
- Fumigant in certain agricultural products
- Sterilant for medical equipment and supplies
- Sterilant for spices, foods



Ethylene Oxide Is Very Toxic

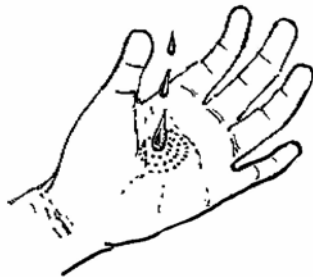
- **Cancer hazard**
- **Reproductive hazard**
- **Mutagenic hazard**
- **Neurotoxic hazard**

Routes of Exposure

How can you be exposed?



- Inhalation



- Skin contact

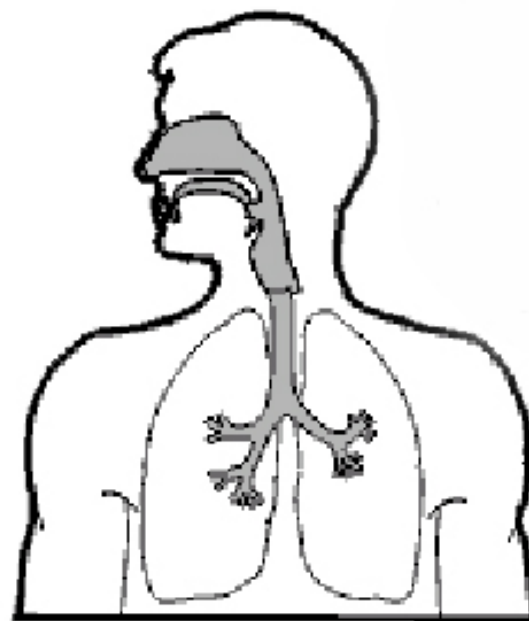


- Eye contact

Health Effects from EtO Exposure

Acute inhalation exposure to EtO can cause:

- Respiratory irritation and lung injury
- Headache
- Nausea, vomiting
- Diarrhea
- Shortness of breath
- Cyanosis - low blood oxygen levels
- Neurological dysfunction at higher concentrations



Health Effects from EtO Exposure

Chronic exposure to EtO can cause:



- Cancer - leukemia
- Reproductive effects
- Mutagenic changes
- Neurotoxicity
- Occupational asthma
(reactive airway syndrome)
- Sensitization

Health Effects from EtO Exposure

Skin effects from exposure to ethylene oxide:

- Severe irritation
- Allergic contact dermatitis
- Second degree burns
- Frostbite
- Sensitization

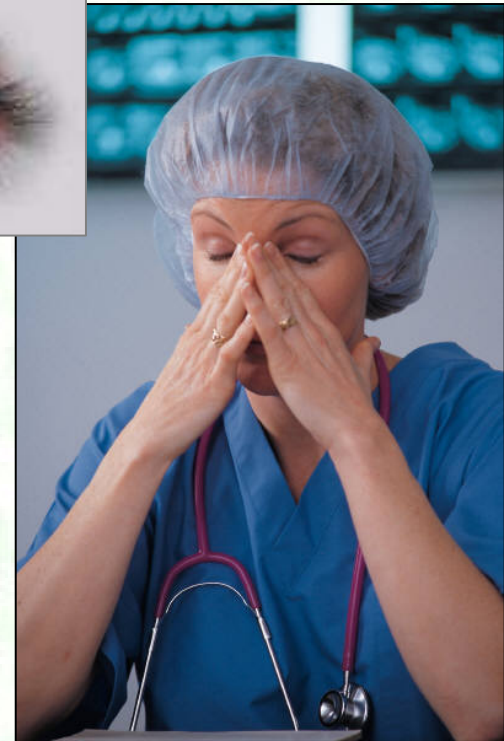


Ethylene oxide dermatitis

Health Effects from EtO Exposure

Eye effects from exposure to ethylene oxide:

- Irritation
- Corneal burn
- Cataracts



How/When Can You Be Exposed?

You can be exposed during:

- Unloading of sterilized or fumigated materials
- Direct handling of sterilized materials (off-gassing)
- Cylinder changing



Removing sterilized items

How/When Can You Be Exposed?

(cont.)

You can be exposed during:

- Inadequate ventilation of the aerator
- Improper/incomplete aeration of the ethylene oxide chamber after the sterilizing process
- Accidental leakage from poor gas-line connections



Aerator

EtO Exposure

The following operations/work areas where you may be exposed to EtO are:

[List the operations in employee work areas where EtO is present.]

Permissible Exposure Limits (PELs)

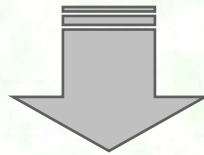
**8-hour time-weighted average
exposure limit (TWA₈):
one part per million (ppm) in the air**

**Short-term exposure limit (STEL):
five parts per million (ppm) in the air**

Permissible Exposure Limits (PELs)

ACTION LEVEL:

**0.5 parts per million in the air
as an 8-hour TWA**



Preventive measures:

- air monitoring
- medical examinations
- labeling
- employee information
- training

Preventive Practices

Warning labels on containers

- On all containers whose contents may cause exposure above action level or STEL
- No other contradicting statements to hazard warning on containers
- On containers of EtO during transport

**DANGER
CONTAINS ETHYLENE
OXIDE
CANCER HAZARD AND
REPRODUCTIVE HAZARD**

**BREATHING AIRBORNE
CONCENTRATIONS OF
ETO IS HAZARDOUS**

Exposure Control Areas



Warning signs posted

- Exposure control areas: identifiable areas where levels of EtO exceed or could exceed the permissible exposure limits (PELs)
- Warning signs posted at access points to exposure control areas

Exposure Control Areas

(cont.)

- Only authorized personnel permitted entry
- Appropriate respirators available for use
- Do not:
 - Eat food
 - Drink beverages
 - Smoke
 - Chew tobacco or gum
 - Apply cosmetics
 - Store food, beverages, or cosmetics



Exposure Control Areas

The following areas are Exposure Control Areas:

[List here all worksite exposure control areas.]

Exposure Control Plan

To reduce your risk of exposure

- Written exposure control plan to reduce your exposure to Ethylene Oxide below PELs
 - schedule for periodic leak detection surveys

Employee rotation is not a method of reducing exposure.



Exposure Control Plan

(cont.)

- Written Emergency Response Plan
 - escape procedures and routes, evacuation plans, procedures for critical operations, rescue and medical duties, respirator requirements
 - reporting procedures for fires, other emergencies
 - contact for further information: *[Insert names of responsible persons or departments.]*
- Employee alarm system - distinctive and recognizable signal
- Exposure Control Plan provided upon request

Reducing Exposures

- Engineering Controls
- Work Practices
- Personal Protective Equipment
- Respiratory Protection

Engineering Controls

Control	For example
Using a different chemical (substitution)	<ul style="list-style-type: none">• Choose a chemical without hazardous ingredients
Changing a process to lessen emissions	
Enclosing or confining the operation/process	<ul style="list-style-type: none">• Build an enclosure around process machinery or other emissions sources
Separating workers from emissions areas and sources	<ul style="list-style-type: none">• Use control rooms
Removing emissions at or near the source (local exhaust ventilation)	<ul style="list-style-type: none">• Install exhaust hoods or slots to capture emissions

Engineering Controls

- EtO only used for materials which are sensitive to heat or moisture and cannot be steam sterilized
- Sterilizers and aerators located so that personnel other than those required by the operations are not exposed
- Double-tank system with a T-valve used to prevent the release of any EtO during the switchover to a new tank

Engineering Controls

- Exhaust ventilation system (hood) installed to protect against accidental releases
- Liquid/gas separator and local exhaust ventilation used to control high levels of EtO at the point of waste discharge
- Specialized gas-line connections to minimize EtO leakage during use and during change-out of EtO cylinders
- Sterilizer/aerator door gaskets, valves, and fittings replaced when necessary

Engineering Controls

Reducing explosion and fire potential:

- Closed handling system - use of inert gas
- Non-sparking, grounded ventilation system
- Direct exhaust to outside; sufficient replacement air
- Approved explosion-proof equipment; intrinsically safe electrical systems
- Leak and fire detection equipment
- Automatic fire suppression system

Control Measures to Reduce Exposures

We use the following controls to reduce the amount of ethylene oxide you are exposed to:

[List controls here]

Work Practices

- Keep container with EtO tightly covered
- Keep in cool, well-ventilated area
- Keep away from ignition source
- Keep areas where EtO is used clear of other materials which can burn (e.g. cardboard, sawdust)

Work Practices

- Keep sterilizer door sealed until the sterilization is completed and the EtO has been removed from the chamber
- Keep sterilized materials as far away from your breathing zone as possible
- Avoid handling materials before they are aerated, by keeping materials in one container throughout the procedures
- If you must handle individual items, use disposable impermeable gloves

Work Practices

- Wear PPE and respirators assigned to you
- Wash your hands before eating, drinking, or smoking or using the bathroom.



Required work practices at this worksite

[List worksite-specific work practices that reduce or control exposures here.]

Hazard Communication Program

All employees must be trained on the hazards of the specific chemicals to which they use or are exposed.

Material safety data sheets (MSDS) provide information on product ingredients and hazards of chemicals.

All employees must have training and access to the MSDS

All containers of chemicals must be labeled with the name and hazards of the contents.

Material Safety Data Sheet

Chemical Name: Ethylene Oxide

Weight By %: 84 to 97%

Chemical Family: Epoxide

Formula: (CH₂)₂O

Molecular Weight: 44.06 gms/mole

CAS Number: 75-21-8

CAS Name: Oxirane

Synonyms: EO, EtO, Dihydroxirene, 1-2 Epoxyethane, Dimethylene Oxide, Oxane, Oxirane, Alkene Oxide, Alpha/Beta-Oxidoethane, Oxacyclopropane.

Product Uses: Chemical intermediate for production of antifreeze, polyester resins, non-ionic surfactants and specialty solvents; sterilizing agent for controlling microorganisms in health care applications; fumigant for controlling insect infestation in whole and ground spices and cosmetics.

Exposure Limits:

NIOSH REL: Ca TWA <0.1 ppm (0.18 mg/m³) C 5 ppm (9 mg/m³) [10-min/day] [See Appendix A](#)

OSHA PEL: [1910.1047] TWA 1 ppm 5 ppm [15-minute Excursion] IDLH Ca [800 ppm] See: [75218](#) Conversion 1 ppm = 1.80 mg/m³

Physical Description

Colorless gas or liquid (below 51°F) with an ether-like odor.

MW: 44.1 BP: 51°F FRZ: -171°F

Sol: Miscible VP: 1.46 atm IP: 10.56 eV

RGasD: 1.49 Sp.Gr: 0.82 (Liquid at 50°F)

Fl.P: NA (Gas) -20°F (Liquid) UEL: 100% LEL: 3.0%
Flammable Gas

Incompatibilities & Reactivities

Strong acids, alkalis & oxidizers; chlorides of iron, aluminum & tin; oxides of iron & aluminum; water

Sample MSDS

Detection and monitoring of ethylene oxide

We measure ethylene oxide in the air. This is called air monitoring and it is done in the “breathing zone” by attaching air sampling devices to employees exposed to ethylene oxide.

You or your representatives are allowed to observe the monitoring.

We must provide written notification of exposure monitoring results to you within five business days after we receive them.



Passive dosimeter for personal exposure monitoring

Notification of results

When employee exposure monitoring results are above either the TWA_8 or STEL permissible exposure limit (PEL), we must provide written notification of all the following within fifteen business days after the results become known to us:

**Corrective actions being taken
and a schedule for completion;**

and

**Any reason why exposures
cannot be lowered to below
the PELs.**

When monitoring results are:

$TWA_8 > 1 \text{ ppm}$

or

$STEL > 5 \text{ ppm}$



Detection and monitoring of ethylene oxide

We also use ethylene oxide detector systems and room monitors to signal any leakage of gas.

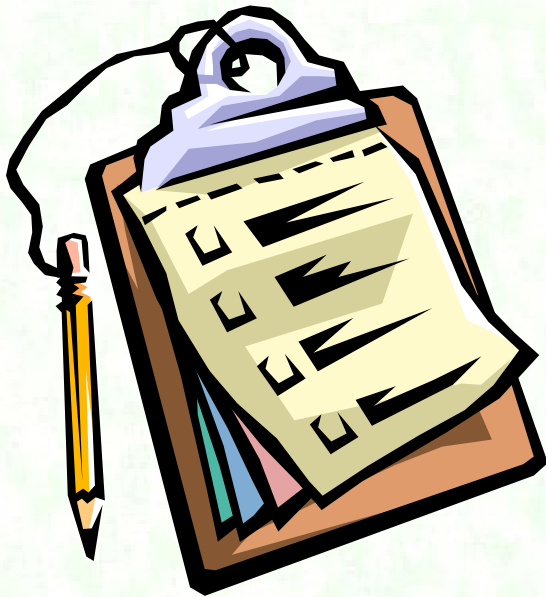


EtO Room Monitor



EtO Monitoring Station

Detection and monitoring of ethylene oxide



We also monitor for leaks at gas-line connectors.

We keep a written log for any detected leak and any service done on an ethylene oxide chamber.

Air Monitoring

These are the results of our air monitoring:

[List results here.]

When would a respirator be needed?

You may sometimes need a respirator while working with ethylene oxide. Examples are:

- During installation or implementation of feasible engineering controls and work practices;
- During maintenance, repair, and certain operations when engineering and work practice controls are not feasible;
- When engineering and work practice controls are not currently available to reduce exposures to or below the PEL; and
- During emergencies

Personal Protective Equipment

When working with ethylene oxide you need to wear:

- Respirators assigned to you
- Eye protection either through the use of full-facepiece respirators, hoods or chemical safety goggles
- Skin protection through chemical protective gloves, coveralls, boots and/or other protective clothing



Personal Protective Equipment

Recommended protective clothing barriers:

For resistance to breakthrough longer than 8 hours:

- Barricade TMcoated suits
- Responder TMsuits
- Trelchem HPS TM suits
- Tychem 10000 TM suits

For resistance to breakthrough longer than 4 hours:

- Butyl rubber gloves, suits, and boots
- Teflon TM gloves, suits, and boots
- PE/EVAL - 4H TM and Silver Shield TM brand gloves

Personal Protective Equipment

Only “chemical resistant” gloves will provide adequate protection for the hands.



1 Hr? 8 hrs?

Type of Respirator You Should Wear

A full face air purifying respirator with EtO-approved cartridge when:

TWA_8 is >1 to 100 ppm

or

STEL is >5 to 500 ppm

It should be equipped with an effective end-of-service-life indicator (ESLI).



Note: Refer to the Assigned Protection Factor Table in 296-842-13005

Type of Respirator You Should Wear

Full face supplied air
respirator when:

TWA_8 is >100 to 1000 ppm

or

STEL is >50 to 5000 ppm



Type of Respirator You Should Wear

Full face SCBA when:

TWA_8 is >1000 ppm

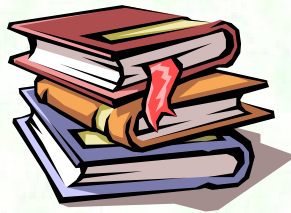
or

STEL is >5000 ppm



Respirators

A respirator program will be followed that meets the requirements of another chapter, Respirators, Chapter 296-842 WAC.



Wearing A Respirator

Respirators must be worn at all times when the amount of ethylene oxide in the air is above the permissible limit.

Respirators must fit properly to prevent leaks.

You must have a medical evaluation before you wear a respirator.

Respirators Must Fit Properly

You must have a respirator fit-test before you wear a respirator.

You can't have a beard or other facial hair when wearing a tight-fitting respirator.

We will train you on how to use your respirator.



Respirators Must Fit Properly

To prevent inhaling ethylene oxide, make sure your respirator fits properly before entering an area where ethylene oxide gas exists.

If you think your respirator is leaking, leave the area immediately and have it re-fitted, repaired or replaced.

If you know or believe you have inhaled ethylene oxide, let your supervisor know immediately.

Type of Respirator You Will Use

[List or describe what respirators must be used under what conditions, job tasks or locations here]

Spills And Emergencies

If gaseous Ethylene Oxide is leaked, or liquid Ethylene Oxide is spilled or leaked:

- Evacuate persons not wearing protective equipment from area of leak until clean-up is complete.
- Remove all ignition sources.
- Ventilate area of leak to disperse the gas and to allow liquid Ethylene Oxide to evaporate.
- Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty.

Spills And Emergencies

- Keep Ethylene Oxide out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations.
- Do not clean up spills unless you have been trained or are part of a designated emergency response team.

Spills And Emergencies

[Detail your emergency response procedures here:]

How to Protect Yourself

In the case of large spill or release of ethylene oxide:

- Leave the area immediately
- Do not attempt to clean up the spill
- Secure the area
- Notify your supervisor

First Aid Response

- **Eye exposure**

- Flush with large amounts of water, lifting upper and lower eyelids

- **Skin exposure**

- Remove any contaminated clothing
- Wash skin with large amounts of water

- **Inhalation exposure**

- Leave area, move to fresh air
- If breathing is stopped, perform CPR
- Keep warm and at rest until medical help arrives

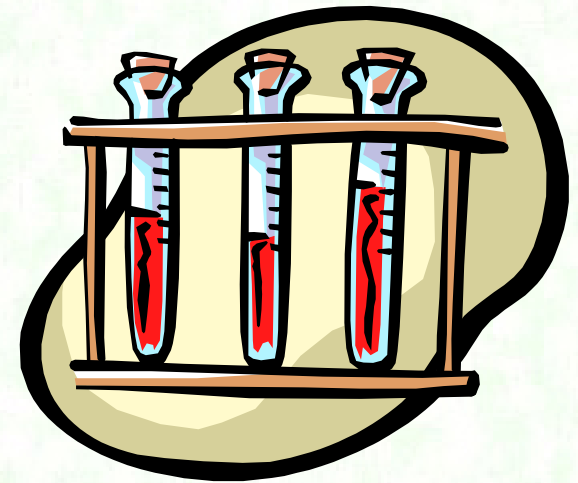
Medical Monitoring

What medical monitoring is needed?

The medical exam is made available to you before you start working around ethylene oxide.

Annual medical exams are made available to you if you are or may be exposed to ethylene oxide above 0.5 ppm, 30 days or more per year.

The medical exam includes a complete physical exam and blood tests.



[Link to contents of medical evaluation](#)

Medical Monitoring

Medical evaluations should also be made available to you:

If you have been exposed to EtO during an emergency situation.

If you want medical advice on EtO exposure and reproductive health.

Whenever you develop signs and symptoms commonly associated with ethylene oxide.

Your rights

Medical evaluations will be provided at no cost to you. This includes travel costs and wages associated with any time spent obtaining the medical evaluation.

The medical evaluations should also be available at reasonable times and places.

When employment with exposure ends, you are entitled to a medical evaluation if you have not had an evaluation within the six-month period before exposure ends.

Results of the Medical Evaluation

We must obtain the licensed health care provider's written opinion for the medical evaluation and make sure that you receive a copy within five business days after we receive the written opinion.



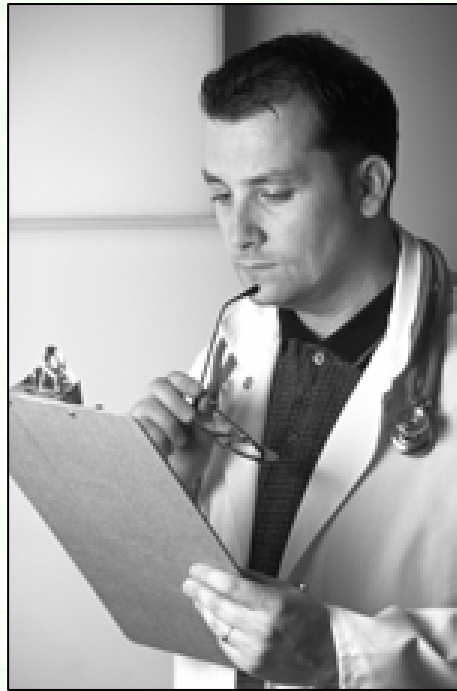
Temporary Medical Removal

If abnormalities show up in the blood tests, the doctor may ask for additional tests and temporary removal from exposure.

In that case, we will find other work for you in an area where you are not exposed to ethylene oxide.



Permanent Medical Removal



Permanent medical removal may be required because of the potential serious health effects of ethylene oxide.

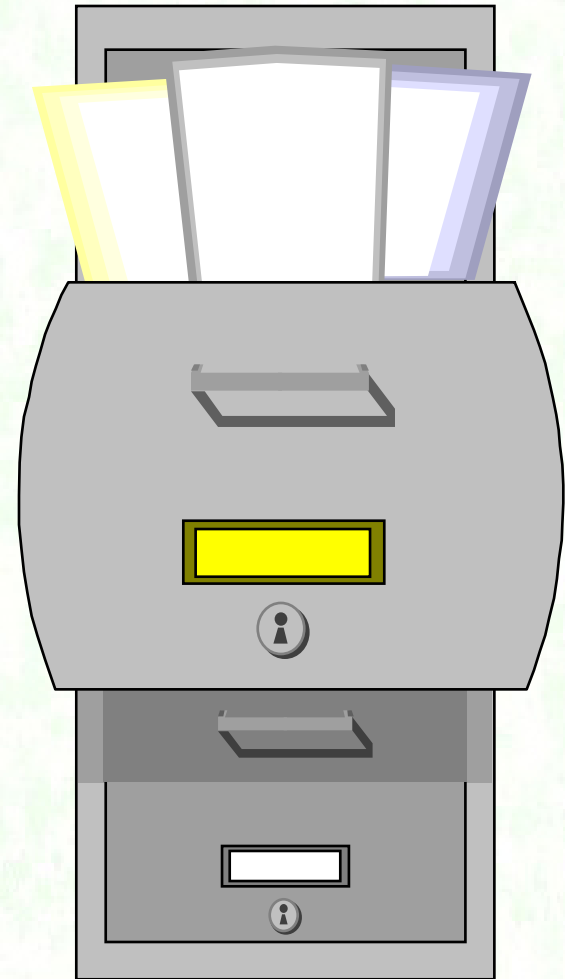
Depending on your medical condition, you may not be able to return to your original position.

If the doctor recommends permanent job removal, we will seek a job transfer for you.

Medical and Air Monitoring Records

You have the right to see any of your medical records related to ethylene oxide.

You also have the right to see results of any air sampling for ethylene oxide we have done.



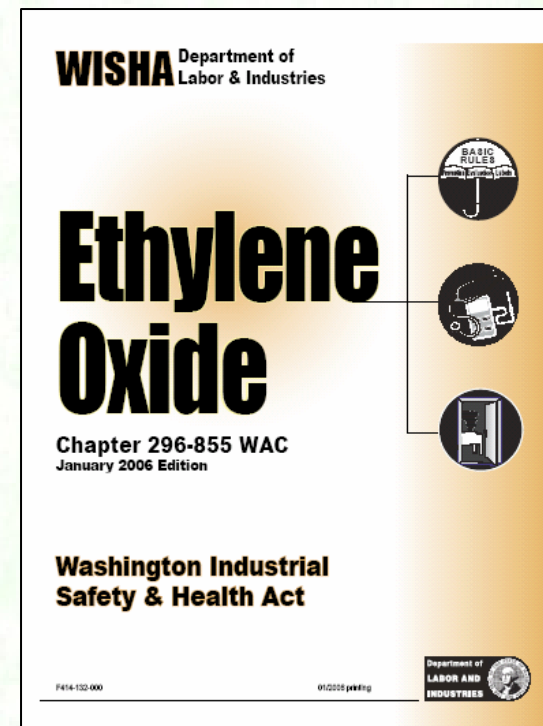
Worksite Medical Surveillance Program

[Describe details of worksite specific medical surveillance program here.]

WISHA Ethylene Oxide Regulations

The WISHA ethylene oxide regulations contains much more information in detail.

A copy of this standard is available.



Links to handouts:

The Substance safety data sheet, [WAC 296-62-07383 Appendix A](#)

The Substance technical guidelines, [WAC 296-62-07385 Appendix B](#)

Medical Surveillance guidelines, [WAC 296-62-07387 Appendix C](#)

Additional Resources

OSHA Hospital eTool – Central Supply Module

- <http://www.osha.gov/SLTC/etools/hospital/central/central.html>

OSHA Safety and Health Topics – Ethylene Oxide

- <http://www.osha.gov/SLTC/ethyleneoxide/index.html>

Canadian Centre for Occupational Health and Safety

- http://www.ccohs.org/oshanswers/chemicals/chem_profiles/ethylene_oxide/

Environmental Protection Agency

- <http://www.epa.gov/ttn/atw/hlthef/ethylene.html>

Additional Resources

National Library of Medicine – Haz-Map

- http://hazmap.nlm.nih.gov/cgi-bin/hazmap_generic?tbl=TblAgents&id=21

NIOSH Alert: Preventing Worker Injuries and Deaths From Explosions in Industrial Ethylene Oxide Sterilization Facilities

- <http://www.cdc.gov/niosh/2000119.html>

New Jersey Department of Health and Senior Services - Hazardous Substance Fact Sheets

- <http://www.state.nj.us/health/eoh/rtkweb/0882.pdf>